N.A.C.A. BULLETIN

In Three Sections

Section One

COSTS IN RELATION TO PRODUCTION RUNS
by ROBERT E. STAUNTON 1117

THE SALES MANAGER AND THE INDUSTRIAL ACCOUNTANT
by MARK W. CRESAP, JR. 1128

BUDGETS AND BUDGETARY CONTROL
by PAUL A. WILKS 1138

STEAM ACCOUNTING
by ROBERT W. ARENTSON 1149

VOL. XXVIII, NO. 18 MAY 15, 1947

EDITORIAL DEPARTMENT NOTE

In most plants there are no longer any quick and easy methods for reducing production costs. The search for cheaper methods has become intensified. Our leading article in this issue revives the question of the determination of the correct size of a production lot or run. If too much is produced, working capital and storage space are tied up with consequent increase in interest and storage costs. If too small a batch is processed, the setup cost per unit becomes excessive.

ROBERT E. STAUNTON, author of the first article, has combined setup, interest, and storage costs in a mathematical formula for determining the optimum size lot. He is a practising Certified Public Accountant, Partner in his firm, and a one-time instructor in production planning at the Rochester Institute of Technology. Mr. Staunton is currently serving as Vice President of the Rochester Chapter.

•

It is a sign of the times that interest in distribution cost accounting is gradually reviving. The coming months will witness an intensifying competition for markets. Our second paper in this issue, while not dealing with the technique of distribution costing, nevertheless provides a blueprint of the cost accountant's function in this field and of his relationship to the sales department.

MARK W. CRESAP, JR., author of the article, is head of his own firm of management engineers, Cresap, McCormick, & Paget, where he is in charge of merchandising surveys. Previously he served as Vice President of the John B. Stetson Co. and was associated with Booz, Allen, & Hamilton. He has had vast experience in the building of programs for advertising and promotion, programs for control of sales expense, creation of territories, traveling and routing plans, etc. In addition he has made market research studies in several industries.

•

The third article deals with the inexhaustible subject of budgets and budgetary control. It deals both with the underlying concepts of budgets and their application through a case study.

PAUL A. WILKS is Controller of Strathmore Paper Co. and a Past President of the Springfield Chapter. During the last war he served as Lieutenant Colonel in the Springfield Ordnance Department.

•

Our last paper deals with the problem of distributing steam costs. It is a joint cost and, like all joint cost problems, it is one capable of many answers.

ROBERT W. ARENTSON, the author, is Chief of the Cost Section of the Hammermill Paper Co. He is a graduate of the Massachusetts Institute of Technology and has spent some time in industrial engineering and the Navy prior to his present job.

This *Bulletin* is published semimonthly by the National Association of Cost Accountants, 385 Madison Ave., New York 17, N. Y. Subscription price, $10.00 per year. Entered at the Post Office, New York, N. Y., as second-class matter August 28, 1925, under the Act of March 3, 1879.

COPYRIGHTED BY THE
NATIONAL ASSOCIATION OF
COST ACCOUNTANTS

MAY 15, 1947

COSTS IN RELATION TO PRODUCTION RUNS

by ROBERT E. STAUNTON,
Partner, Robert E. Staunton & Co.,
Rochester, N. Y.

ONE of the major fields of cost reduction available to management today, when established selling prices are close to or below anticipated production costs, lies in the control of the direct cost of products. One explored area in this field, and one which will particularly interest the cost accountant, is the control of cost by predetermining the economically correct production lot size before the issuance of a production order. Many planning department heads and other production control executives use various modifications of the old "rule of the thumb" methods for determining the quantity to be produced at any given time, but in general this subject has been, in the past, considered to be rather outside the field of the cost man.

A study of the basic costs of any one of our products will, however, establish clearly the fact that the cost man, having available the current labor and material cost of the product and in many cases standard or actual setup costs applicable to each product, has before him the basic factors essential to the determination of economical production lot size.

In addition to factory cost and setup cost, the cost of initiating a production order (including clerical, planning, and scheduling time), the cost of storing the part after processing (including the interest cost of the money tied up in the inventory), the cost of storage records and periodical physical inventories, etc., provide all of the basic factors essential to this calculation. Another factor which is currently discussed as affecting the control of the size of economical production lots is the turnover of capital in the business under consideration, including the rate of return per dollar of investment in that business. The truth of the matter is that, while the turnover of capital and the rate of return on investment are definite factors which could enter the calculation, a practical point of view in studying these factors indicates that their influence on the size of the lot is in many cases negligible and in very few cases of serious consequence to the result.

Starting Costs

It is quite obvious that the cost of setup and the cost of initiating the order, including clerical, planning, and scheduling, can be grouped together in the development of a formula which may be used to determine correct lot size. This initial cost of setup, order entering, planning, and scheduling must be spread over the number of pieces manufactured in one run, and this unit cost decreases as the size of the order increases. What is not quite so obvious is the fact that this decrease in cost bears a direct relationship to the quantity produced and that this relationship, when set forth graphically, produces a hyperbolic curve (Exhibit 1). However, the attempt to control lot size through reference to setup cost only results in building an excessive inventory which is always dangerous, and which will be suicidal in the competition which our vast research organizations are now developing.

The decrease in cost may be measured by the formula $C = \frac{S}{Q} + T$ where C = cost per finished piece.

S = setup cost, including clerical.
T = total unit factory cost for material, labor, and overhead.
Q = quantity produced in one lot.

In this formula $\frac{S}{Q}$ = the setup cost per unit.

By spreading the fixed setup over larger and larger quantities, successively smaller unit costs are obtained. Thus assuming that S equals $10 per setup and T equals $.10 per piece, and the quantity per lot varies from 1,000 to 10,000, the cost per piece will vary from $.11 to $.101, as illustrated in Exhibit 1 and in the figures below.

Quantity	*Formula*	*Unit Cost*
1000 pcs.	$\frac{10 + 100}{1000} = \frac{110}{1000}$	.11
2000 pcs.	$\frac{10 + 200}{2000} = \frac{210}{2000}$	.105
3000 pcs.	$\frac{10 + 300}{3000} = \frac{310}{3000}$	.1033
4000 pcs.	$\frac{10 + 400}{4000} = \frac{410}{4000}$	.1025
5000 pcs.	$\frac{10 + 500}{5000} = \frac{510}{5000}$	.102
10000 pcs.	$\frac{10 + 1000}{10000} = \frac{1010}{10000}$	.101

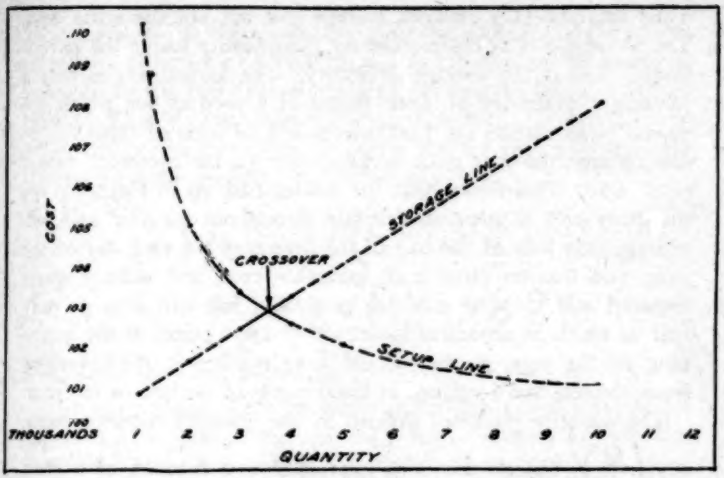

EXHIBIT 1

The chart (Exhibit 1) illustrates the nature of the curve and establishes the fact that minimum cost is not attainable, because infinite production in one run would be required to attain it. The factor which will govern the practical, usable area of this curve is the rate of consumption of the product which may be expressed in terms of pieces required per year. This control factor can only be applied in a formula for determination of correct lot size by converting the pieces required per year into a monetary value, which will begin at some point on the curve to offset the apparent advantage of lower cost for greater production. The simplest approach to this conversion is through the cost of handling, storing, insuring, and financing the various production quantities on an annual basis.

Storage Cost

The straight line in Exhibit 1 is based on the following formula:

$$C = T + \left(\frac{T}{2} \times E \times \frac{Q}{A}\right)$$

in which C and T represent the same things as before.

E = interest rate to represent the cost of financing, insurance, and handling.

A = number of pieces required annually.

Thus the cost (C) includes storage cost but not the setup cost. The storage cost is represented by the quantity inside the parenthesis. T/2 is the average inventory. The assumption is that a January 1 inventory of 1,000 pieces of a product for which the annual requirements are 1,000 pieces will be reduced from day to day through the year until, at December 31, the inventory would equal zero. This means that the dollars tied up in financing the inventory will, in general, decrease throughout the year and will average only half of the cost of the inventory for each day of the year, and that handling cost, insurance cost, and storage space required will likewise diminish gradually, but will average only half as much on an active inventory of 1,000 pieces at the beginning of the year, as they would have reached if the inventory were obsolete and remained at 1,000 pieces to the end of the year.

The quantity produced divided by the quantity required annually, $\left(\frac{Q}{A}\right)$, reflects the time, expressed as a fraction of a year, that the production lot (Q) will remain in stores. In developing the straight line, 8 per cent was used to reflect financing, insuring, and handling the inventory; the latter includes rent on the storage space. In practice the storage cost represented by "E" may vary from 3 per cent or 4 per cent on simple parts to 40 per cent or 50 per cent on expensive parts requiring high labor and material and special storage arrangements. The figures below are those used in plotting the straight line in Exhibit 1.

Quantity	*Formula*	*Unit Cost*
1000	$.10 + \left(\frac{.10}{2} \times 80 \times \frac{1000}{5000}\right)$	$.1008
2000	$.10 + \left(\frac{.10}{2} \times 80 \times \frac{2000}{5000}\right)$	.1016
3000	$.10 + \left(\frac{.10}{2} \times 80 \times \frac{3000}{5000}\right)$	.1024
4000	$.10 + \left(\frac{.10}{2} \times 80 \times \frac{4000}{5000}\right)$	.1032
5000	$.10 + \left(\frac{.10}{2} \times 80 \times \frac{5000}{5000}\right)$	.1040
10000	$\left(\frac{.10}{2} \times 80 \times \frac{10000}{5000}\right)$	.1080

The quantities and costs for material, labor, and overhead for the two lines shown on Exhibit 1 are identical. The curved line on the chart represents setup cost; the straight line, storage and

handling costs. It is obvious, then, that the total cost of the various quantities reflected by both lines will be the sum of the costs represented by the two lines minus $.10, because the basic or factory cost of $.10 is necessarily included in both lines. In short the total cost per unit is made up of the factory cost plus the setup cost plus the storage cost. Mathematically

$$C = T + \frac{S}{Q} + \left(\frac{T}{2} \times E \times \frac{Q}{A}\right)$$

$$= T + \frac{S}{Q} + \left(\frac{TE}{2A} \times Q\right)$$

Economic Quantity Formula

The intersection of the two lines in Exhibit 1 is at a volume of approximately 3500 pieces. At the point of intersection the total cost under both formulas used in plotting these lines is the same. Moreover, it can be shown that at the point of intersection, the cost is at a minimum. Hence the two formulas representing equal costs at the intersection point can be equated and the quantity to be run mathematically determined.

$$\frac{S}{Q} + T = T + \frac{TEQ}{2A}$$

$$2AS = TEQ^2$$

$$Q = \sqrt{\frac{2AS}{TE}}$$

Now assume that $S = \$10$
$A = 5000$
$T = \$.10$
$E = 8\%$

$$\text{Hence } Q = \sqrt{\frac{2 \times 5000 \times 10}{.10 \times .08}}$$

$$Q = \sqrt{\frac{100000}{.008}}$$

$$Q = 3536$$

This then is the optimum size lot when 5,000 units are required per year with a ten dollar setup charge, an 8 per cent storage cost, and a ten-cent product. Exhibit 2 has been developed to show that the resulting total cost including factory, setup, and storage costs is at

a minimum for a production run of 3,536 units. If desired, the information in Exhibit 2 may be plotted to show the same facts. In either case, the cost of producing 3,500 or 3,600 will vary from the lowest possible cost by so slight an amount as to be negligible; but the production of three months' supply (1,250), six months' supply (2,500), or a year's supply (5,000) will produce costs which are materially higher than the cost of 3,500 pieces.

SETUP AND STORAGE COSTS FOR DIFFERENT SIZED LOTS

(1)	(2)	(3)	(4)		
Quantity	*Unit setup cost*	*Storage cost*	*Setup and storage* (2) + (3)	*Excess cost* Amount	Per cent
600	$.01667	$.00048	$.01715	$.01149	203.00
1000	.01	.00080	.01080	.00514	90.81
1250	.008	.00100	.00900	.00334	59.01
2000	.005	.00160	.00660	.00094	16.61
2500	.004	.00200	.00600	.00034	6.01
3000	.00333	.00240	.00573	.00007	1.24
3536	.00283	.00283	.00566	—	—
3750	.00267	.00300	.00567	.00001	.18
4000	.0025	.00320	.00570	.00004	.71
5000	.002	.00400	.00600	.00034	6.01

Given Facts:

Basic factory cost (T) = $.10
Setup cost (S) = $10
Interest rate (E) = 8%
Annual requirement (A) = 5000 units

Storage cost $\left(\frac{TE}{2A} \times Q\right) = \frac{.10 \times .08}{2 \times 5000} \times Q$

Formula: $C = T + \frac{S}{Q} + \left(\frac{TE}{2A} \times Q\right) = .0000008 \times Q$

Note: The above table does not include the basic factory cost (T). It is necessary only to show the excess setup and storage costs.

EXHIBIT 2

Application of Formula to Short Runs

With the formula for the economic size run we are able to determine the correct quantity for any product, because the formula represents all important variables in the cost of preparing for manufacture, manufacturing, and holding the goods in storage until used. However, the application of the formula every time a production order is required presupposes clerical time and calculating equipment to be available in quantities sufficient to apply the formula. It is possible to reduce the time necessary to apply the formula by converting it into a chart which sets forth the

setup cost, including clerical planning, order issuing, etc.; the cost of the item for material, labor, and factory expense; the storage cost, represented as a percentage of the cost of the piece; and the rate of turnover, represented by the annual requirements. This chart would be constructed in such a manner that with any known setup cost, book cost, expense rate, and annual requirements the chart may be used to determine the low-cost quantity.

What is probably most cogent to the practical cost man who is interested in cost reduction, is a discussion of the possibilities of savings expressed in dollars or as a per cent of present expenditures. In support of the practical value of the formula, Exhibit 3 is submitted setting forth several variations of the prime factors entering into the cost of preparing for production, producing, and storing for use of a given product. It illustrates the cost of the parts in lots of from 100 to 1,000 pieces and also the cost of the quantity shown by the formula to be the low-cost quantity.

The table in Exhibit 3 sets forth four examples with setup costs ranging from $10 to $80, piece cost ranging from $15 down to $1.50, and storage cost ranging from 5 per cent to 40 per cent, all on the basis of an annual consumption of 1,000 pieces. If it is customary in a plant to manufacture a three months', four months', six months', or a year's supply—as is the case in many manufacturing establishments—this table permits a study of the result of arbitrarily producing various monthly allotments. For the purpose of comparison, the setup and storage costs are shown as a separate item apart from the cost of the piece. There is also shown all setup and storage cost in excess of that required to produce the economic quantity, in terms of dollars and percentage.

In the first example in Exhibit 3 setup and storage cost on a run of 100 pieces is 17 per cent higher than on the economic run of 163 pieces, and it increases from 8 per cent excessive setup and storage cost on 250 pieces to 225 per cent excessive setup and storage on a full year's run of 1,000 pieces.

In the second example of Exhibit 3, the economic quantity is 258 and the cost of 250 pieces, representing three months' production, shows no measurable increase over the economic run of 258. However, the production of 100 pieces increases setup and storage cost 44 per cent, and the production of 500 pieces, six months' supply, shows 19 per cent excess setup and storage cost, while one year's production of 1,000 pieces shows 100 per cent excess setup and storage cost.

		Economic quantity	100 Pieces	¼ Year 250	½ Year 500	1 Year 1000
1. Setup	$10					
Material, labor, and overhead	$15					
Quantity required annually	1M					
Storage rate	5%					
Economic quantity	163					
Cost		$15.12	$15.14	$15.13	$15.21	$15.39
Setup and storage cost		.12	.14	.13	.21	.39
Excess cost setup and storage		—	.02	.01	.09	.27
Excess cost per cent setup and storage		—	17%	8%	75%	225%
2. Setup	$20					
Material, labor, and overhead	$ 6					
Quantity required annually	1M					
Storage rate	10%					
Economic quantity	258					
Cost		$6.16	$6.23	$6.16	$6.19	$6.32
Setup and storage cost		.16	.23	.16	.19	.32
Excess cost setup and storage		—	.07	—	.03	.16
Excess cost per cent set up and storage		—	44%	—	19%	100%
3. Setup	$40					
Material, labor, and overhead	$ 3					
Quantity required annually	1M					
Storage rate	20%					
Economic quantity	365					
Cost		$3.22	$3.43	$3.24	$3.23	$3.34
Setup and storage cost		.22	.43	.24	.23	.34
Excess cost setup and storage		—	.21	.02	.01	.12
Excess cost per cent setup and storage		—	95%	9%	5%	56%
4. Setup	$80					
Material, labor, and overhead	$ 1.50					
Quantity required annually	1M					
Storage rate	40%					
Economic quantity	516					
Cost		$1.81	$2.33	$1.90	$1.81	$1.88
Setup and storage cost		.31	.83	.40	.31	.38
Excess cost setup and storage		—	.52	.10	—	.07
Excess cost per cent setup and storage		—	168%	32%	—	23%

EXHIBIT 4

Application of Formula to Large Runs

In order to illustrate the application of the economic lot size formula to larger runs, Exhibit 4 has been prepared. This table is based on an annual consumption of 100,000 pieces with setup cost ranging from $150 to $1,500. The latter might represent the complete rearrangement of one or more departments for the production of a special product. Piece costs range from 80 cents per piece down to 10 cents per piece and storage rates from 40 per cent down to 5 per cent. Looking at Exhibit 4 in its entirety, economic quantities range from 9,682 to 244,949 pieces. The production of 1,000 pieces, or three months', six months', or a year's output can cause excessive setup and storage cost ranging from 67 per cent to 433 per cent in the first example, 50 per cent to 1,400 per cent in the second example, 50 per cent to 2,900 per cent in the third example, and 100 per cent to 14,900 per cent in the last example.

We suggest that you compile a set of tables similar to Exhibits 2, 3, and 4 on five or ten of your products, and then average the results. Weight the average if necessary and, in the light of your knowledge of your own production methods, determine for yourself whether you are producing too small a quantity on the average or too large a quantity, and percentagewise how much too small or too large. Finally, apply that percentage factor to the cost of your planning and setup organizations and your stores organization and determine for yourself the savings possibilities in your company.

The amount of error which can creep in due to ordering one, two, or three thousand less than the economic quantity is tremendous. The figures presented in the exhibits are arbitrary, but a table can be developed from your own products, and the information which it gives will be very valuable in helping to sell management a cost reduction program based solely on the correction of ordering practice in the production office.

Application to Purchasing

The same principle can, of course, be applied to the purchasing department's efforts. The application is made by determining the cost of issuing one purchase order. This may be determined by very accurate study and analysis of the work of all of the purchasing department's employees, or by dividing the cost of the

		Economic quantity	1000 Pieces	¼ Year 25,000	½ Year 50,000	1 Year 100,000
1. Setup	$150.00					
Material, labor, and overhead	.80					
Quantity required annually	100M					
Storage rate	40%					
Economic quantity	9,682					
Cost		$.83	$.95	$.85	$.88	$.96
Setup and storage cost		.03	.15	.05	.08	.16
Excessive cost setup and storage		—	.12	.02	.05	.13
Excessive cost per cent setup and storage		—	400%	67%	167%	433%
2. Setup	$300.00					
Material, labor, and overhead	.40					
Quantity required annually	100M					
Storage rate	20%					
Economic quantity	27,386					
Cost		$.42	$.70	$.42	$.43	$.44
Setup and storage cost		.02	.30	.02	.03	.04
Excessive cost setup and storage		—	.28	—	.01	.02
Excessive cost per cent setup and storage		—	1400%	—	50%	100%
3. Setup	$600.00					
Material, labor, and overhead	.20					
Quantity required annually	100M					
Storage rate	10%					
Economic quantity	77,460					
Cost		$.22	$.80	$.23	$.22*	$.22**
Setup and storage cost		.02	.60	.03	.02	.02
Excessive cost setup and storage		—	.58	.01	—	—
Excessive cost per cent setup and storage		—	2900%	50%	—	—
4. Setup	$1500.00					
Material, labor, and overhead	.10					
Quantity required annually	100M					
Storage rate	5%					
Economic quantity	244,949					
Cost		$.11	$1.60	$.16	$.13	$.12
Setup and storage cost		.01	1.50	.06	.03	.02
Excessive cost setup and storage		—	1.49	.05	.02	.01
Excessive cost per cent setup and storage		—	14900%	500%	200%	100%

* Cost differential appears in third decimal place.
** Cost differential appears in fourth decimal place.

MAN

entir
a "r
cost
quo
by a
ing
If th
of c
mula
Th
tion
area
savi

entire purchasing department by the number of orders issued for a "rule of thumb" figure. This figure then represents the setup cost in the formula and when applied to the cost of the piece as quoted by the manufacturer, and the storage cost as determined by a study of the storage problems including financing and insuring cost, will determine the quantity most economical to purchase, If the purchasing agent has two quotations, one on 100,000 pounds of castings and a slightly better price on 500,000 pounds, the formula will reveal which lot to buy, without any guesswork.

The control of lot size has not been given sufficient consideration to date, but it is probably now one of the most remunerative areas for investigation and for the realization of significant dollar savings.

COMING ARTICLES

In the **N. A. C. A. Bulletin**, June 1, 1947

Twenty-five Years Growth of Cost Accounting
by J. Hugh Jackson

Does Your Incentive Wage Payment Plan Measure Up?
by E. A. Cyrol

Effective Disposal of Peacetime Surpluses
by Robert A. Morgan

THE SALES MANAGER AND THE INDUSTRIAL ACCOUNTANT

by MARK W. CRESAP, JR.,
Partner, Cresap, McCormick and Paget,
New York, N. Y.

ACCOUNTING is concerned with and affects the work of every department of an industrial organization. As a consequence, the chief accounting officer has in his possession more figure facts about the condition and performance of the business as a whole than any other executive under the president. Despite this fact the accounting officer seldom participates as fully or as effectively in shaping major management policies and practices as his unique knowledge of the company's affairs warrants. His participation is, in my experience, least active in the area of sales management, a condition which is rather strikingly indicated by the small number of articles on this subject which have appeared in the publications of the N. A. C. A. during the past fifteen years.

This apparent lack of emphasis on the introduction of the accountant's knowledge and skill into the planning and control of sales activities should be of particular concern to management today, due to the importance of maintaining a realistic and objective analysis of sales performance under current inflated economic conditions. The danger of being misled by these conditions today was aptly summarized by Stanley Z. Bronner, in a recent issue of the *N. A. C. A. Bulletin,* as follows:

"Under these abnormal circumstances it is easy to be fooled into thinking that a given enterprise has found a new place in the sun, or that it has improved its relative competitive position, or that new permanent customers have been acquired to broaden its field of operations."*

Mr. Bronner emphasizes the fact that when such false ideas are permitted to develop through failure to analyze various elements of the sales base realistically, management has lost sight of the true position of its business.

Students of organization, in commenting on the inadequate development of the accounting function in management, have been prone to lay the full blame on the accounting officer himself be-

* *NACA Bulletin,* March 15, 1946, p. 634.

cause, to use their own phrases, the accountant in many instances has "failed to raise his sights" and "thinks in bookkeeping rather than executive terms." Such generalizations are not only unfair, but, more important, they do not offer any tangible program for solving the problem. In order to avoid the appearance of indulging in such pointless criticism I would like to base my comments on two specific points:

1. What are the primary reasons for the rather passive relationship which often exists between the accounting officer and the sales manager?
2. What are the principal opportunities today for introducing accounting knowledge and skill into the planning and control of sales activities?

Causes of Problems

My firm is frequently called upon by its clients to analyze and evaluate their sales policies and programs. Such a study requires detailed, painstaking analysis of many factors concerning market coverage and sales volume, broken down both productwise and accountwise. These studies usually lead us to the accounting department where, on the whole, the most complete and authoritative sales records are maintained. Usually these records supply answers to many of our questions after they are correlated in terms of the problem we are examining. On such occasions management is surprised at the wealth of information available within the confines of its own organization, and we are often asked why such facts cannot be provided on a current basis by the accounting organization. In answer to this query we have normally found that one or more of the following steps must be taken if management is to secure more appropriate utilization of the accounting service with respect to sales activities.

The Accounting Officer in the Executive Organization

The conventional accounting department is, in the view of some executives, a "figure factory"—a group of clerks, surrounded by adding and calculating machines, preparing complicated forms which record the income and expense history of the business. Where management persists in restricting the accountant's position to this narrow, routine, "after-the-fact" status, it is unlikely that the accounting organization will produce more than a good

set of books and operating statements. Thus it is essential that management revise its own understanding of the potentialities of the accounting function, if it is to receive from the accounting department a positive, dynamic service with respect to the management of the business. It must redefine the place of the accounting officer in the executive organization.

That there is such a place for accounting in management can be readily recognized when one considers the principal elements which constitute the task of management. Three distinct activities must be carried on by management:

1. Planning. This encompasses the determination of basic product design and the formulation of long-range production and sales objectives, plans, and programs. Primary responsibility for such management planning necessarily falls to general management.
2. Execution, or the implementation of the basic engineering, production, and sales plans. These responsibilities devolve upon the key production and sales executives.
3. Control. This requires a comprehensive and continuing evaluation of the status and success of the production and sales program. This task can usually be performed most effectively by the chief accounting officer, since he possesses the necessary figure facts as well as the skill and objectivity required to interpret these facts for top management.

The first requisite to greater utilization of accounting knowledge and skill is a complete redefinition of the mission and responsibilities of the accounting officer. This redefinition must recognize that the gathering and reporting of accounting facts are not the "end products" of the accountant, but are rather the means by which he can exercise the control function for management. Under this concept, for example, if the sales department lacks a sound basis for establishing sales quotas and measuring sales performance, it should be the responsibility of the accounting officer (the control expert in management) to see that a proper market analysis program is developed. Or, if distribution practices are not based upon a factual analysis of the costs of servicing accounts of various types and sizes, in various localities, it should be the responsibility of the accounting executive, in collaboration

with the sales manager, to assemble and analyze the facts pertinent to this matter.

"Merchandising" the Accounting Service to Management

Next in importance to revising the concept of the accounting officer's place in management is the fact that he must learn the art of "merchandising" the accounting service to management. While the reports and statements published by the accounting department contain many of the facts necessary to evaluate the sales and profit performance of the company, these facts are often not displayed in a form which stimulates study and analysis by executives who are unskilled in the use of accounting data. Thus, in laying the basis for more adequate collaboration with the sales manager, the accounting officer must consciously take a page from the sales manager's book by doing a more imaginative job of merchandising the accounting service. Many features, small in themselves, can contribute to the increased use and acceptance of accounting reports.

1. One feature is the appearance of the report or, in the sales lingo, the way in which the material is "packaged." One of the most interesting presentations of operating data that I have encountered recently is the monthly report of the Comptroller of United Air Lines. This volume of vital operating statistics is bound in an attractively printed folder carrying the title "HOWGOZIT."
2. The arrangement and content of reports is, of course, of major importance. As far as possible the data should be reduced to significant indices and trend charts, properly highlighted, and should be free of unnecessary details and technical accounting terms.
3. Another practice which will stimulate the use of these important facts is prompt reporting of "fresh" information. The accountant can learn a valuable lesson from the journalist by increasing the "news value" of his reports through timely reporting of operating results.

It might be a good plan to invite the sales manager to work with the accountant in dramatizing the appearance, readability, and utility of the reports. His suggestions should prove of substantial value and at the same time stimulate the sales manager's interest in, and understanding of, the accounting service.

Specialized Staff Assistance

As the third principal step in removing the causes for the inadequate participation of the accountant in sales management, I believe that the accounting officer should supplement his staff to include a specialist competent to interpret and service the needs of the sales manager.

At times we find that even though the accounting officer has been clearly charged with the management control function and has enlisted the interest of the production and sales executives, he is still unable to provide adequate attention to the requirements of these executives due to the inadequacies of his own staff. I was quite interested in reading recently a recommendation by George Rooney, Vice President of the U. S. Steel Corporation, that an industrial engineer be on the staff of the cost accountant to provide specialized assistance in the analysis of cost data from the manufacturing standpoint. I would like not only to confirm my agreement with this recommendation, but also to urge that a sales and marketing analyst be placed on the staff of the accounting officer to render expert assistance in the preparation of studies for the sales department. This step is very important even in large companies which have a separate sales analysis unit reporting to the sales manager, since in these cases much of the sales and product data needed by the sales department must be drawn from the basic accounting records and reports. In smaller companies, it may be economically unfeasible to maintain a full-time member of the accounting staff to specialize in the figure control requirements of the sales function. This does not alter the basic principle that such a responsibility should be established, on a part-time basis if necessary.

Accounting Opportunities in Sales Activities

Thus far in our discussion we have considered the reasons which have delayed or prevented more active collaboration between the accounting officer and the sales manager. I would like to summarize briefly the principal opportunities which exist in many companies today for the introduction of accounting knowledge and skill into the planning and control of sales activities.

Dean J. Hugh Jackson of Stanford University has pointed out that "the purpose of accounting is to aid management, not to find fault with it," and that the true purpose of the cost accountant is

"the leading of management into a searching examination of its working plans, methods, physical facilities, and manpower, in order that defects and weaknesses may be discovered and corrected." This point of view is particularly important in laying out a positive program for collaboration with the sales manager, who can benefit immediately today from the development of new bases and new facts on which to develop postwar marketing and distributing plans. The thoughtful accounting officer will find that his service to the sales manager has three distinct aspects:

1. The aid he can render in improving the administration of the sales department.
2. The aid he can render by serving as the link between the sales manager and the production manager in the replanning of product lines, price schedules, and related matters, on the basis of complete and reliable facts and figures.
3. The assistance he can render in the establishment and revision of sales and distribution plans, policies, and programs.

I would like to mention briefly a few specific projects under each of these headings which the alert accounting officer should undertake today in cooperation with, and in support of, the sales manager.

Administration of the Sales Department

The accounting officer should plan specific studies of matters such as the following:

1. Sales compensation practices, including commission and bonus arrangements. These studies should be aimed at determining whether existing practices are equitable as between individual salesmen, whether they direct salesmen's efforts into the most profitable channels, and whether they bear a proper relation to the earnings of the business.
2. Branch office expense. Periodic review of the cost of maintaining branch sales offices, in relation to the sales and earnings of each, is necessary to guide the expansion, contraction, or elimination of such activities.
3. Advertising and promotion expense. Yardsticks for the objective appraisal of the sales return being produced

by such expenses can be formulated by the sales manager with the assistance of the accounting officer to provide a factual basis for controlling these sizeable expense items.

4. Salesmen's expense. Careful review of this item, again with a view to arriving at reasonable standards, often pays dividends through the elimination of extravagance and abuses of the expense account privilege. Furthermore, the accountant can be of assistance to the sales manager in establishing effective current controls over salesmen's expenses.

Providing a Link Between Production and Sales

The accounting officer will find several points at which the interests of these two departments can be more effectively harmonized if pertinent accounting facts are developed for their joint consideration. Four important subjects which should be covered in this connection are the following:

1. The proper composition of the product line, as to the range of sizes, colors, etc., to be offered in each quality. These decisions should be based upon the collective knowledge and judgment of the manufacturing executive from the standpoint of production economics; the sales executive from the standpoint of distribution and marketing economics, and the accounting officer from the standpoint of cost economics.
2. The establishment of realistic price schedules, based upon comprehensive cost data, both direct and indirect, usually available to the accounting officer. This is an activity in which the accounting executive today already plays an active part in most companies, because it is ultimately related to his orthodox responsibilities. This function ties in closely with the next suggested role of the accountant as a coordinating factor between sales and production.
3. The establishment of adequate sales budgets. This may sound elementary on first consideration, but I am constantly impressed with the fact that even in well-managed companies these budgets do not meet the requirements

of the case. Too often the budgets are related only to the general or financial budgets and are not extended to the point where they provide a firm basis for sales plans, production scheduling, purchasing, and inventory control. By an adequate sales budget, I mean one which elaborates the basic dollar sales forecast into a schedule of unit sales by detailed product and type classifications, by appropriate time intervals, as an intelligent basis for forward planning of all elements of the business.

4. The development of economic studies and business forecasts. The introduction of new products and services, as well as the expansion and contraction of existing product lines, should be based upon reliable economic studies and business forecasts. The modern industrial accountant knows the sources of such data and should provide management with continuing advice on the general business outlook, price trends, cost of living trends, and similar factors affecting the production and consumption of products marketed by the company.

Revision of Sales Plans

With regard to the establishment and revision of sales and distribution plans, policies, and programs, the accounting officer will find that the sales manager is constantly faced with many complex problems whose solution requires intensive analysis of facts often available in the accounting department. There are at least three major phases of the sales program which should be periodically appraised or replanned with the advice and assistance of the accounting officer:

1. Sales objectives and quotas. The accountant's knowledge of the present distribution of sales by states, counties, cities, territories, etc., provides many of the basic data required in replanning sales objectives and quotas. Furthermore, if the sales department is not staffed to conduct market studies leading to the determination of market potentials, the accounting officer should arrange to provide this specialized service.
2. Product promotion policies. Changing consumer demand, induced by competitive conditions, technological advances, and similar factors, are often clearly reflected

in the sales trend of individual product lines. The accounting officer who maintains continuing scrutiny of sales volume trends by products is able to identify quickly abnormal or unforeseen sales variations, and thus to focus attention on desirable revisions in product promotion policies and programs.

3. Marketing and distribution policies. Sales managers who are not conscious of the cost of servicing accounts of various types and sizes often neglect to establish realistic objectives as to the kind and size of accounts which should be sought. The accounting officer should therefore test current distribution policies against questions such as the following, where they are applicable:

   a. Should distribution be restricted with respect to the type or number of accounts to be sought in various localities?

   b. Should accounts whose annual purchases are low be replaced or dropped if more satisfactory volume cannot be obtained?

   c. Should a minimum order limit be set to screen out unprofitable orders?

   d. Can accounts in small towns or accounts whose annual purchases are low be serviced more economically by the use of jobbers or a mail order plan of sales coverage?

   e. Are there large volume accounts whose purchases are not profitable due to the type of product bought or to unusual installation and maintenance services required?

The above questions are covered merely to illustrate the scope of the critical appraisal of distribution policies which the alert accounting officer should undertake.

Summary

In this paper I have outlined briefly a suggested program for strengthening the participation of the industrial accountant in the planning and control of sales activities. While this entire program is probably not applicable in every situation, I believe it poses the primary considerations against which the accounting officer can

evaluate the adequacy of his present relationships with the sales manager. In summary, this program comprises four steps:

1. Management must redefine the place of the accounting officer in the executive organization by delegating to him appropriate responsibility for the management control function.
2. The accounting officer must learn the art of "merchandising" the accounting service to management.
3. The accounting officer should supplement his staff to include a specialist competent to interpret and service the needs of the sales manager.
4. The accounting officer should initiate a comprehensive program for assisting the sales manager in improving the administration of the sales department, particularly with regard to sales compensation practices; by serving as the link between the sales and production managers in the replanning of product lines, price schedules, and related matters, on the basis of complete and reliable facts and figures; and by appraising the adequacy of sales and distribution plans, policies, and programs.

BUDGETS AND BUDGETARY CONTROL

by PAUL A. WILKS,
Controller, Strathmore Paper Co.,
West Springfield, Mass.

THE subject at hand may be segregated into two classifications; namely, the development of the theory underlying budget preparation, and the application of such theory in the case study presented herewith.

The Need for a Budget

In ordinary times, or what we like to think of as ordinary times, the budget was based on three factors:

1. A study of past performance.
2. An analysis of present conditions.
3. An estimate of future conditions, especially as they affect our industry and, particularly, our company.

Knowing what happened in the past, we tempered that knowledge with known changes in present conditions—new equipment, current costs of raw material and labor, etc.—and we estimated our sales for the next year, after giving consideration to expected business conditions. The budget was then prepared and, if it was prepared properly, maximum results were obtained by comparing the budget figures with actual results.

Today a study of past performance, certainly the immediate past, is not worth too much consideration in preparing a new budget. The war with all its upheavals makes past performance unsafe as a guide to the future. Therefore, more reliance must be based on the second and third factors mentioned above.

The need for a budget is acute, whether in normal times or in this postwar period. A budget is a guide to future planning, a measuring stick of present performance and, possibly, the basis for paying supervisory bonuses. It may be a useful argument to use in negotiating a wage contract. It answers many questions which arrive at unexpected moments.

Responsibility for Budget Preparation

To me it is axiomatic that all budget work should be done with the full cooperation of those whose performance will be gauged

by the results shown when that budget goes into operation. This does not mean that only the figures to be combined in the budget should receive this approval; more than that is needed. The method by which the budget figures are obtained needs the full understanding and approval of all concerned. All this means budget preparation should be started early enough to allow time for discussions with those responsible.

I believe further that one man should be entirely responsible for the preparation of all budget figures, although in most organizations he will require much assistance. No matter what this man's title may be—treasurer, assistant treasurer, controller, auditor, to name a few possibilities—he should be responsible to the president of the organization. In his work he should deal with the top operating executives, as well as superintendents and foremen, and therefore the man responsible for budget preparation should, in case of disagreement, be able to contact a man still higher in the organization. Moreover the approval of the completed budget should come from the very top of the organization. Such a condition will enhance the prestige of the final figures.

Developing Sales Budget

The estimated sales for the budget period should be prepared in the sales department and receive the approval of the head of that group before being passed on to the budget director. How much detail is considered in arriving at these figures depends upon conditions. For example, in our organization we used to have each salesman estimate the sales in his territory by customers by grades. The figures thus obtained were checked by the vice president in charge of sales with these questions in mind:

1. Do anticipated business conditions warrant such a budget?
2. Will any grades be added to our line and, if so, what effect do we expect them to have on our present product?
3. Do we expect to alter the sales and advertising emphasis now being placed on our different types of papers?

Upon the answers to these and similar questions depended the final sales budget passed along to the budget director.

Conditions were vastly different when our 1947 budget was drawn up. Paper was being sold on a quota basis, raw materials

were hard to obtain, almost any paper we made could be sold. Therefore a simpler method of setting the sales budget was used. Representatives of the sales department made up an over-all budget by grades, without the breakdown of former years. The result was passed upon by the sales manager before going on to the budget director.

Setting Standards

With the sales budget in hand the next problem is to determine whether it can be made with existing equipment and personnel and, if it can, what will the cost be. In our organization we have a standard cost system tied in with the general books. It is necessary that we have standard costs available and to get these costs, and at the same time provide an operating budget, we draw up practically two complete production budgets. The first is based on five-day operation in all production centers at 100 per cent operating efficiency. (In passing, let me say that 100 per cent operating efficiency under our standards represents a goal attainable by an average operator under normal conditions. This efficiency level is met and passed in many cases.) From this budget we set our expense rates and set up our standard costs as far as labor and burden are concerned. Raw material costs are computed by pricing standard furnishes, or materials, at raw material costs. The work on this budget can be done while we are awaiting the sales budget for the ensuing year.

Production Budget

However, the budget which interests us particularly is the one based on the sales budget. Here are the steps which we follow in this case.

1. We allocate to each of our six paper machines the anticipated production of the grades which it normally produces. We ascertain whether the machine can produce (at 100 per cent efficiency) the amount assigned, and if this is not possible arrangements are made to shift some of the production to other machines.
2. We estimate the amount of paper which will pass through each of our production centers. Some of this work is distinctly an estimate because paper goes out in different finishes, and definite tonnage in each is not known until actual orders are received.

3. We divide the estimated sales (in pounds) for each grade by the standard beater yield to get the number of beaters to be made. Then, from our standard beater furnish, or material, we know the pounds of each ingredient used per beater. Multiplying the weight of rags used in each beater by the number of beaters to be made gives us the total pounds of rags needed for the anticipated production of that grade for the year. The total weight of each type of material used for all grades of paper is found in this way, and when priced at standard values gives the total cost of raw material for the budget.

4. I mentioned above that we estimated the amount of production anticipated for each production center. Therefore, to get our labor and burden expense we estimate by production centers the cost of processing the paper scheduled for that center. Remember that we have prepared by this time a budget based on five-day operation throughout the mill. These figures can be taken into consideration in setting up the budget for anticipated production, but in so doing these things must be considered:

   a. Certain expenditures vary directly with the level of production.
   b. Others fluctuate but not in direct proportion.
   c. Still others remain fixed at all levels of production.

   We, as would any other organization, have information about these matters and are able to develop costs for each center, and the sum of these gives us the direct labor and burden costs for our budget. Included in all our computations is an allowance for the bonus paid for operation at 100 per cent efficiency.

5. To complete our budget for the cost of goods manufactured we estimate what our variance accounts will show for the year. Past experience, anticipated levels of operations in various centers and a knowledge of available raw materials all help in setting these figures. For your information, here are some of our variances:

   a. Operating time gain or loss—the cost of idle equipment.

b. Manufacturing efficiency gain or loss—the saving or loss resulting from operation at more or less than 100 per cent efficiency.
c. Purchase Gain or Loss—the results of buying raw materials at more or less than standard allowances.
d. Material gain or loss—the results of substituting nonstandard raw materials for standard or of achieving a yield from materials furnished which differs from standard results.

Operating Expense Budget

The sum total of the figures developed so far is the cost of goods sold section of our budget. The next step is to prepare the sales, advertising (a part of sales cost), and administrative expense budgets. A careful estimate of each type of expense is made—salaries, travel and entertainment expenses, office supplies, stationery, fees for professional services, contributions, membership dues, telephone and telegraph charges, to name some of them. Each estimate is checked against past experience, present and future policy, and other known facts in order to arrive at a reasonable total. The detailed figures are set up in the budget in exactly the same way as they appear on our financial statements.

The advertising budget is set up in a slightly different manner. The over-all amount to be spent for this purpose is decided upon, taking into consideration market conditions and the anticipated sales for the year under consideration. For example, when the 1946 budget was set up the allowance for advertising was cut to the bone because it was felt that nothing more than institutional advertising and a small amount of sampling would be needed. Certain items, such as salaries and other administrative expenses, are estimated in detail, but the remainder is inserted in the master budget more or less as a lump sum, even though the advertising department has some rather definite ideas on how the money will be spent. Expenditures are classified in detail as the year progresses and are reflected under the proper headings in our financial statements.

Two relatively unimportant figures are needed to complete our operating budget. These are the figures for Other Income and Other Expense, but no discussion of methods is needed here.

The budget, the presentation of which has been described in more or less detail, is presented to our executives in the form of

an operating statement with supporting schedules and rather detailed explanatory comments. In almost every case it resembles the periodic financial statements.

We feel, however, that no budget is worth the work put into it unless, during the period which it covers, it is used to compare actual performance with the estimate. Thus it should become a means of control. How should a budget be administered to achieve this purpose?

The Administration of a Budget

Our first consideration in the administration of a budget is this: it will be a miracle if the actual production during the life of any budget is in accord with that scheduled. Therefore we feel that the arbitrary division of the annual budget to get the budget for any smaller period of time is unfair to the budget and to any person who is being judged by the relation between his actual expenditures and budget allowances. In short, as far as labor and manufacturing burden are concerned a flexible budget is set up—an expedient which, we feel, allows us to set up a reasonable budget to cover the actual production in a given period of time. In brief, here is our procedure.

1. We determine a so-called unit of measurement for each production center. Such a unit may be machine hours, man hours, direct labor dollars, paper machine hours, among others.
2. We set up a budget allowance to be granted for each standard unit of measurement earned. In so doing we consider those items which vary in ratio directly with production; semivariable items are included through the use of curves to show variations at different levels of operation; fixed items are brought into the budget at a fixed amount per period.
3. We determine for the production of each center for each period
   a. The actual expenses.
   b. The standard number of units earned.
4. We set up the budget for the period by multiplying the units earned by the budget allowance for variable expense and by making the necessary adjustments for semivariable and fixed expenses.

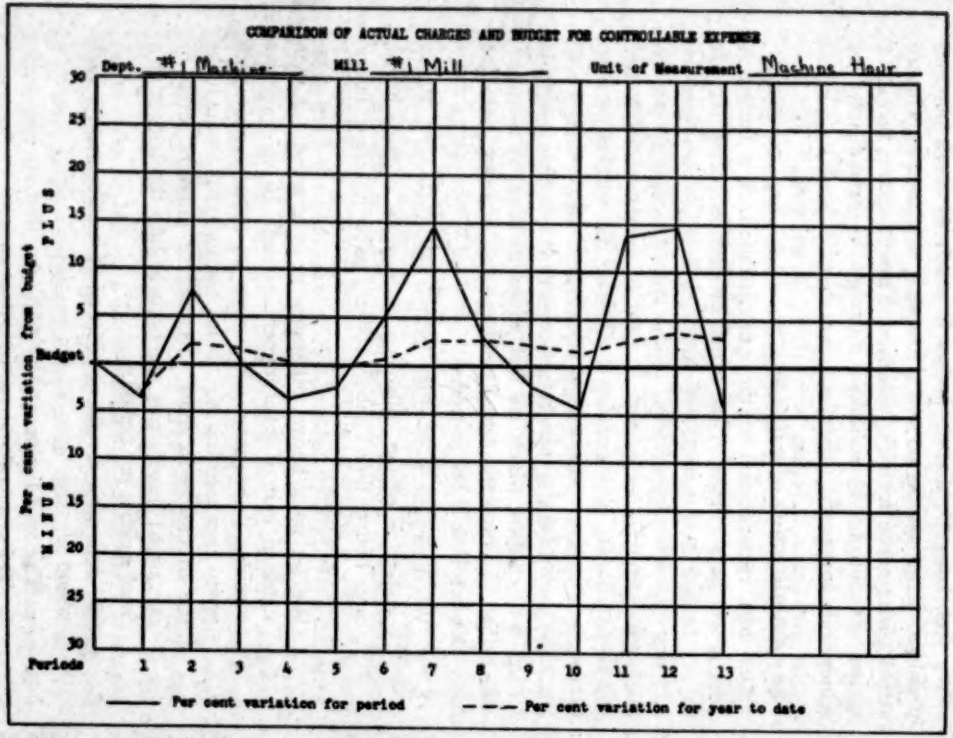

EXHIBIT 1-a

DEPT. #1 Machine	DATA AND EXPLANATIONS FOR ABOVE CHART				MILL #1 Mill.
PERIOD	BUDGET	ACTUAL	% PER.	% YR.	EXPLANATION OF LARGE VARIATIONS

DEPT. #1 Machine DATA AND EXPLANATIONS FOR ABOVE CHART MILL #1 Mill.

PERIOD	BUDGET	ACTUAL	% PER.	% YR.	EXPLANATION OF LARGE VARIATIONS
1	$ 3321	$ 3198.60	96.4		
2	3518	3792.30	107.9	102.2	Operating efficiency for period only 91%. Indirect labor cost $42 over budget.
	6839	6990.90			
3	3168	3126.35	100.7	101.8	Operating efficiency has improved to 102%, but indirect labor cost is slightly over budget.
	9942	10117.15			
4	3316	3201.10	96.5	100.5	
	13258	13318.25			
5	3442	3384.17	97.7	99.9	
	16720	16702.42			
6	3497	3675.10	105.1	100.5	
	20217	20377.52			
7	3216	3693.10	114.8	102.7	Charges for machine clothing $328 over budget for period, but in line for year to date.
	23433	24070.62			
8	3412	3516.27	103.0	102.8	
	26845	27586.89			
9	3176	3121.10	98.3	102.3	
	30021	30707.99			
10	3237	3097.12	95.7	101.6	Operating efficiency at high point for year – 111%.
	33258	33805.11			
11	3278	3742.73	114.2	102.8	Cost of indirect labor $275 over budget; supplies $195 over.
	36536	37547.84			
12	2932	3362.12	114.7	103.1	Supplies in line again, but indirect labor shows an increase in spite of 11% drop in operating time.
	39468	40909.96			
13	3169	3025.02	95.5	103.0	
	42637	43934.98			

EXHIBIT 1-b

5. We compare the budget with the actual expense and the difference is shown as a gain or loss on our Budgeted Expense Gain or Loss Variance account.

This is a brief outline of a subject which has had a good deal of our thought and which is the basis of the procedure which we follow in trying to control our expenditures. A discussion of how we use the budget results to make our mills cost-conscious may be of interest and will give a further insight into our methods.

Budget Reports

The financial statements, which are issued at four-week intervals, show for various mills the relation between budget and actual expense in the major departments, such as manufacturing, finishing room, mill general expense, etc. These complete statements are sent to executives and that part which deals with the budget comparison to mill superintendents and foremen. For executives these consolidated figures can give enough general information, but for the supervisory force in the mill we feel that more detailed information is required.

To meet this need we have developed a chart and accompanying page of comments. (Exhibits 1-a and 1-b.) Remember that actual expenditures are checked against a budget which varies with the conditions existing in each period. That means that in no two periods will the budget be the same in dollars, and precludes the use of a dollar scale on the chart. Our solution to the problem is to show a line that represents the budget and to reflect the difference between budget and actual as a per cent above or below budget. The solid line shows the percentage variance for any one period; the dotted line the variance for the year to date.

On the page of comments which adjoins each chart this information is shown:

1. The budget for the period and the year to date.
2. Actual expenditures for the period and the year to date.
3. The ratio of expense to budget for the period and the year to date.
4. Explanations for sharp variances from budget, or suggestions on points that either need attention or indicate trouble brewing.

Budget Conference

A mill superintendent or foreman receives as soon as possible after the close of each period a book of charts, one covering each production center for which he is responsible. This reaches him at the same time as his copy of the financial statements, and with this material is a request that he hold it until we have an opportunity to discuss it together. During the time which elapses before this discussion it is hoped that the mill supervisor will look over the financial statements, the charts, and the comments, and he is urged to have questions ready to discuss.

On my part, I prepare for my round of conferences by listing points which I should like to discuss. With me at the time of meeting is the expense detail book which itemizes all charges, a detailed budget setup which gives allowances for all expense items, and other special material which seems indicated.

To me, these talks are extremely important. At each one an attempt is made to draw out questions from the supervisor. If possible an answer is given on the spot; otherwise it is forwarded as soon as the necessary facts can be accumulated. An effort is made to offer suggestions for improving current conditions, and to learn if any changes in procedure are contemplated, especially any alterations which would necessitate revision of flexible budget allowances. And all the time it is desirable to maintain as friendly a relationship as possible with the man in the plant, because without the proper relationship, frank and exhaustive discussions on methods of reducing costs would be impossible. Sometimes, if a point of interest is important enough, a report of the situation is typed in advance to serve as a basis of discussion, or is prepared after the talk and sent back to the plant to serve as a record of our meeting.

We consider the periodic conferences to be a vital part of our setup, to be well worth the time spent, and we hope that those in the mill share our opinions.

Benefits Obtained from a Budget

Unfortunately, I cannot cite any definite tales of thousands of dollars saved here or hours saved there. But here are some of the results which seem to me to make our efforts worth while, together with illustrations which seem to prove the point. First of all, the factory supervisory organization becomes cost minded and interested in anything which affects the charts. Thus, one

foreman found his indirect labor charges in a production center were going up and also his operating efficiency—a suspicious combination of events. Investigation showed an employee was turning in incorrect time notes. Result: a chastened employee, honest time notes, less indirect labor charges, and an operating efficiency which represented actual facts.

One production center showed an extremely high operating efficiency; but spoilage discovered in later operations was nearly twice that of the previous year. Out of the discussion came a request for further and continuous information for a few weeks. Result: a careful study by the superintendent responsible and a determination on his part of what should be the proper speed of operation in order to obtain the maximum results.

Methods are sought to combine jobs so that slack periods in one place can be used to meet a peak load in another, resulting in better showings in each center when actual expense is compared with budget.

A useful by-product of our conference procedure is that the factory becomes acquainted with the office and vice versa. Both get to know the other's problems and as a result more efficient cooperation results. Again, executives have sore spots pointed out. With us, this comes through our financial statements and through a chart book, with charts like those we have discussed, but showing results for groups of departments instead of for individual production centers. This is a relatively new procedure with us and at the moment we do not know whether the benefits derived will justify its continuance.

Conclusion

Budgets, their preparation and administration, have been discussed in this paper, and the procedure followed in my company outlined to some extent. It is realized that the plan is nowhere near perfect; we would be foolish to think so. But we do feel that we are getting results, if for no other reason than the remark of one foreman. At one of the first discussions of his chart book, he said, "I'm glad to have someone checking up on me. It shows what I am doing and it makes me more careful." Anything that shows how we are doing, that points out where the difficulties are, and suggests possible remedies, eventually will pay dividends to the company which sponsors the plan. Try it and see for yourself.

STEAM ACCOUNTING

by ROBERT W. ARENTSON,
Chief of Cost Section, Hammermill Paper Co.,
Erie, Pennsylvania

IN THE chemical, rubber, petroleum, paper, and other process industries steam is an important item of cost, frequently amounting to 20 per cent of the total processing cost. A proper solution to the many problems encountered in accounting for steam costs would seem to be a problem to which cost accountants would have given much attention. Inspection of the literature shows that relatively few accountants have written anything on steam costs, while in engineering journals a hardy perennial problem is the analysis of steam costs. The number of papers has increased as more and more plants have installed high pressure boilers to supply steam to exhaust turbines for power generation with the exhaust being used for process heat.

This situation is true probably because the engineer understands the basic thermodynamic theories and terminology which must be the basis of any rational study of steam costs. Unfortunately, the engineers have arrived at about as many answers to the problems as there are engineers writing on the subject. An accountant would quickly recognize that an important reason for the many varying opinions is the difference in the type of cost being talked about. Steam costs are used for many purposes and different concepts of cost must be used for each purpose.

Engineer and Accountant

Engineers have spent many hours developing complex thermodynamic equations to obtain a split between steam costs chargeable to generation of electricity by turbines and to the processes using the exhaust steam from the turbines. In most plants the engineer winds up with a set of figures giving the pounds of steam which should be charged to the generation of electricity and to the various cost centers throughout the plant. The accountant, who has been standing on the side lines, usually takes this set of figures with the feeling that they have been arrived at by a rigid formula which cannot be altered. So he blissfully tacks a dollar sign onto the figures and enters the result in the books. Probably the engineer has buried many things in his physical distribution

which would be of vital importance to the accountant if he knew of their existence.

The handling of steam costs is a field in which cooperation between accountants and engineers is essential. The accountant will always go to the engineer for the basic steam data. The engineer must go to the accountant for an understanding of the accounting principles involved in the handling of steam costs.

Basic Thermodynamics and Cost Accounting

The application of the fundamental rules which are basic to engineering thermodynamics and to cost accounting can do much to provide a reasonable approach to the problem. The accountant can quickly clear away many difficulties by introducing the concept of different costs for different purposes. The problem becomes much simpler once it is recognized that the cost which should be used for distribution purposes may not be the cost to use for control purposes and is probably not the cost which can be used to select between engineering alternatives. Splitting the cost of high pressure steam between electrical generation and process heat will be recognized by the accountant as a joint cost problem, hence one which has no single right answer. This explains the many answers arrived at by the engineers in their study of the distribution of steam costs.

Thermodynamic Definitions

To understand the problems encountered in arriving at the physical figures used as a basis for obtaining and distributing steam costs, a knowledge of engineering thermodynamics would be desirable. However, once the term B.T.U. is defined and the general theory behind a couple of thermodynamic expressions is understood a reasonable approach can be made.

When we talk about steam reference is usually made to the heat which it contains. The unit of heat in English speaking countries is the British Thermal Unit, the abbreviation of which (B.T.U.) is usually used. One B.T.U. is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

The enthalpy of steam is its total energy content and is usually expressed in B.T.U. per pound. Older terms for the same thing are heat content and total heat. As the older terms indicate, en-

thalpy can be used as a measure of the amount of heat which can be obtained from a pound of steam.

The theoretical amount of work which can be obtained from a pound of steam under certain operating conditions is known as the "available work" in the steam. As the name indicates, this is the measure of the amount of work which the steam can do and is also usually expressed as B.T.U. per pound.

Boiler House Costs

Determination of the cost of producing steam is a relatively straightforward problem. Accumulation of the charges to the boiler house with reasonable detail and with a segregation of the controllable and uncontrollable costs will provide the information necessary for determining the cost of the steam produced and to hold the operator responsible for those costs which he can control.

If more than one pressure of steam is produced, or if different types of boilers are in use, segregation of costs by steam pressure or boiler type is desirable. Such segregation will be needed by the accountant and engineer in making policy decisions.

Of equal importance are the production figures which are usually the responsibility of the power plant operator. Here the accountant must recognize that steam meters are not an exact measuring device and some margin of error must be allowed. Accountants who feel that things must be accounted for to the last penny are greatly disturbed when the net steam production figures and the amount of steam distributed fail to agree by one per cent to three per cent. After a few sessions in which the engineer has tried, probably without success, to explain the reason for the discrepancy, he finds it easier to plug the figures so they appear to be exact.

Distribution of Steam Costs

The boiler house in industrial plants does not produce a salable product, and the cost of its operation must be distributed to the producing departments. In boiler houses where only one pressure of steam is produced and all steam is used for process use the distribution problem is relatively simple. Installation of meters which measure the amount of steam consumed by the producing departments will provide the required information. Distributions can be established in test runs by installation of temporary meters and at times can be calculated with reasonable accuracy.

Where all steam generated is at one pressure but the boiler efficiency varies from boiler to boiler, an average cost should be used for distribution purposes. This will avoid the inequalities which might be introduced if the high cost steam from an inefficient boiler was charged to a single department.

In boiler houses producing both high and low pressure steam the problem becomes more complicated. It is usually a relatively simple job to segregate and establish the cost of production of each steam. Unfortunately, if the high pressure boilers are newer and more efficient boilers, which is usually the case, the cost of the more valuable high pressure steam may be less than that of the low pressure steam. In such a case conversion to a common base with an expression of cost on a value basis would seem to be justified. This problem is much the same as that encountered when high pressure steam is fed to a turbine exhausting steam for process use.

Distribution of Cost Between High and Low Pressure Steam

When high pressure steam is fed to an exhaust turbine, power is produced by the turbine, yet all of the steam going into the turbine comes out of the turbine and is available for process use. On a quantity basis it could be argued that no charge should be made to power since no steam was consumed. This approach is incorrect because inspection of the exhaust steam reveals that its enthalpy is lower than that of the high pressure steam and the amount of available work has been greatly reduced.

The distribution of the cost of the high pressure steam can best be approached by an evaluation of the value of the steam. This can best be done by use of the thermodynamic expressions just outlined.

The most common method of distribution is based on the enthalpy of the steam. Using this procedure, electrical generation would be charged in proportion with the loss in enthalpy of the steam as it goes through the turbine. Production departments using the exhaust steam would be charged with the balance of the cost of the high pressure steam. This method assumes that the primary use of the steam is to produce process heat and any power produced is a by-product and should bear only a minor portion of the cost of the high pressure steam.

In many cases the use of the enthalpy method of distribution makes the cost of electricity so low that it may be misleading.

Where high pressure boilers are installed to obtain the economies of joint use, the savings are all reflected in a low electric power cost instead of being split between electricity and process steam.

If the primary use of the steam is to produce power, the use of available work as a basis for distribution is indicated. The bias in this approach is just the reverse of the enthalpy method. Available work charges the major portion of the steam cost to the generation of electricity, thereby greatly reducing the portion of the cost allocated to the exhaust steam.

In most plants the generation of electrical power and the use of the exhaust steam for process heat are important. In these plants a weighted average of the enthalpy method and the available work method would seem to provide the best answer.

Reducing to a Common Basis

Since the amount of steam is not reduced when it goes through a turbine it is apparent that pounds of steam alone cannot be used for the distribution of steam costs. One of the most practical bases is the high pressure steam to which all other steams are related by the factor obtained by the use of the available work and enthalpy methods of distribution. Thus, a 650-pound steam may have a factor of 1, the 35-pound steam exhausting from a turbine might have a value of .7, and a pound of the 150-pound steam generated by 150-pound boilers might be equivalent in value to .8 pounds of 650-pound steam.

If the enthalpy method of distribution is used, the distribution can be reduced to a B.T.U. basis or can be converted to a theoretical steam. Use of 1,000 pounds of a specified steam is recommended since it is easier to visualize a pound of steam than it is to picture 1,000 B.T.U.

Control of Steam Consumption

Control of the use of steam can only be obtained by the use of meters. Without the use of meters there is no check on the steam used by any department and the responsibility for excessive steam consumption cannot be determined. The high installation cost of steam meters and the constant maintenance required indicates that only those plants with large steam costs can afford to make the installation necessary to control those costs.

To control steam consumption properly standards of consumption must be established. These standards may be based on past

performance, but will be sounder if tempered by the thermodynamic calculations of the engineer. Control of steam consumption can best be obtained by daily reports of the physical quantities of steam consumed. Little is gained by affixing the dollar sign to the physical quantities. For historical purposes and to tie steam costs in with other costs they can be converted to dollars for the monthly cost reports and for reporting to management.

Selection from Alternatives

It must be remembered that the split made between high and low pressure steam is for distribution and control only. It has little value when making policy decisions as to the purchase or installation of new equipment. For this cost determination an overall balance must be used to arrive at the correct answer. It is conceivable that in a plant with an excess of exhaust steam, the exhaust steam should, for the purposes of the immediate problem, be considered to have no cost.

Summary

The analysis of steam costs is a problem requiring the best efforts of the accountant and engineer. Only through the cooperative effort of these technically trained people can a reasonable solution to the problems of steam costs be obtained. The engineer with his concepts of basic thermodynamic theory can provide the basis for the proper proration and distribution of steam costs. The accountant with his concept of different costs for different purposes can eliminate much of the confused thinking which has hindered solution of the problem in the past.